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ANAESTHESIA IN WAR SURGERY.

Thesis for the Degree of M.D.

Presented by

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For the past fifteen months, I have been attached to the Third Australian General Hospital as Anaesthetist, and now record my experiences gleaned from somewhere over a thousand cases of anaesthesia in war surgery.

I may conveniently divide up the time in question into three equal periods of four months each. During the transfer of the hospital from England to France, and its subsequent establishment as a base hospital on the lines of communication, no surgery was possible for a period of about three months.

During my first four months with this unit we existed as a General Hospital at Brighton in England, where practically all our patients arrived from the Base Hospitals in France. From the end of July to the end of November, 1917, I was attached to a Casualty Clearing Station in Flanders, where I gave anaesthetics for one of our own hospital surgeons, working together as "a team" all through the Flanders offensive. There remains a period of four months during which I have either been giving anaesthetics or instructing others in their use, at our Base. Although it is not my intention to quote figures extensively, it may be of interest to give the number of anaesthetics given by/

by me in those three periods.

I find at Brighton I gave just under 300 anaesthetics.

At the Casualty Clearing Station (C.C.S.) exactly 650.

At the Base Hospital upwards of 150, so that my experience of war anaesthesia is derived from a variety of operations in 1100 cases. In considering the experience gained by those anaesthetics, I think my object will be best attained by considering.-

1. The type of Patient.
2. The type of Anaesthetic given.
3. The type of wound and operation for which the anaesthetic was required.

1. Type of Patient:-

(a) At Brighton the patients had almost all - with the few exceptions of emergency operations for accident or illness amongst our own staff - been operated upon in France, so that nearly all the operations were secondary.

In the great majority of cases the patients were in good condition for undergoing an operation; they had been in hospital some time prior to the operation, and could be properly prepared both for the operation and the anaesthetic. Occasionally I had to give an emergency/

emergency anaesthetic for a secondary haemorrhage, where the patient was more or less collapsed from loss of blood, but this was rare.

(b) At the Casualty Clearing Station quite a different state of affairs prevailed, and it was here that I gained much experience from an infinite variety of cases.

The patients with practically no exception had been wounded from four to forty-eight hours previously. From the firing line they had passed through the various Dressing Stations to the C.C.S. and on arrival there were at once sent to either the pre-operation or resuscitation wards.

On four occasions our team worked for three or four days on shifts of sixteen hours, in the operating theatre, and eight hours off, in each twenty-four hours.

On account of the stress of work and number of patients requiring operation, a few may have waited over forty-eight hours before operation, but this was unusual.

Frequently we had to work for sixteen hours out of the twenty-four, but we generally managed to get the cases cleared off by the second day. At the C.C.S. when a rush of work was in hand there was no correct method/

method of estimating when a patient would go into the theatre, or to which surgeon he would go, so that the only preparation carried out was the restriction of his diet whilst in the pre-operation or resuscitation wards.

Many of the patients had never been in hospital before, many had been through the most terrible and trying experiences of battle and had no nerve left to face an operation, and many were in a condition of extreme collapse from the gravity of their injuries.

(c) At the Base, most of my anaesthetic work has been carried out during a "quiet" time in the front line, so that the operations have been mostly those performed on patients who had already had an operation done at the C.C.S., or whose slighter wounds had become septic, and required opening up and drainage. Local admissions of accidental injuries or sickness (such as appendicitis or empyema) and "clean" operations for the cure of hernia, haemorrhoids or varicocoele made up the numbers. All those cases were able to be in hospital for some time prior to operation, and could be properly prepared. Here again secondary haemorrhages were practically the only immediate operations requiring an anaesthetic; those are of course much more common over in France than they were in England.

2. Type of Anaesthetic given:-

Under this heading I include the four general anaesthetics and the local anaesthetic I have been in the habit of using. Those were.- (a) Chloroform, (b) Ether, (c) Ethyl Chloride, (d) Gas and Oxygen. For local anaesthesia Novocain has given the surgeons such satisfactory results that we used it solely when a local anaesthetic was deemed advisable.

(a) Chloroform:-

As a graduate of Edinburgh University I received my initial training in the use of anaesthetics with Chloroform alone, and I cannot recollect seeing any other anaesthetic used whilst I was a student in the surgical wards between 1896 and 1900. Yet in the series of cases I am now considering there were not ten cases in which I used Chloroform per se throughout the operation - that is less than 1% of the cases. My reasons for departing from the routine use of this anaesthetic some ten years ago (and here I may say it was a gradual departure extending over a considerable number of anaesthesias in the course of my first five years in Australia) were simply that I considered Ether a safer anaesthetic to give as a routine. I have had very little experience of the Vernon Harcourt inhaler, but practical experience has taught me that a low/

low percentage of Chloroform vapour is essential for the safe conduct of your patient throughout an operation, and I know that the "bad moments" I have had when giving anaesthetics have almost all arisen when I was giving Chloroform in some shape or other. In my war work I have confined the use of Chloroform throughout to those few cases where the chest condition contra-indicated the use of Ether. At Brighton I used it in one or two cases where the patient had a bad bronchitis. At the C.C.S. the only cases in which I used it were on patients who had the misfortune to be gassed prior to being wounded, or in penetrating injuries to the chest wall. In those latter cases it was combined with oxygen in a light form of anaesthesia only. I have found in penetrating chest wounds however, that gas and oxygen is a valuable anaesthetic, and I have been giving that method for choice while stationed at my base.

In giving Chloroform with oxygen, the method I have adopted is to induce on an open mask by the usual drop method, then fix the tubing from the oxygen cylinder on to the air supply end of a Shipway's apparatus, and thus bubble the oxygen through the chloroform bottle, with just sufficient velocity to keep the patient slightly under. Indeed I have found that with the Shipway method of delivering the warmed vapour of either/



either chloroform or ether - or a mixture of the two - I could frequently give those chest cases a mixture of chloroform and ether plus oxygen, without any of the irritating properties of the ether manifesting themselves.

I will refer more fully to the value of ether and oxygen under the section dealing with Ether Anaesthesia. In giving oxygen with chloroform alone, one has to be careful not to give too strong a vapour by too great a flow of oxygen. In those cases demanding a good supply of oxygen this danger can be avoided by substituting plain warm water for ether in the ether bottle, and switching the control tap of the Shipway apparatus as far over to the ether as is desired, thus giving a good supply of oxygen (taking the bubbles through the chloroform and plain water as a guide) with very little chloroform. Although as I have already stated, I have not used chloroform per se in 1% of my cases I am fully aware of its advantages as an anaesthetic in combination with ether.

The mixture I have been in the habit of using is 2 (two) parts chloroform and 3 (three) parts ether: this C.E. mixture is now my routine method of inducing anaesthesia in the great majority of cases where the operation is likely to extend to a period of 20 minutes or longer. I find I use from 2 to 8 drachms of this mixture/

mixture on an open mask, covered with one layer of turkish towelling. I prefer this turkish towelling to lint or gauze as it preserves a free air way and the ether is not so liable to freeze as on lint. Before applying this mask I cover the patient's face with a piece of gamgee wool out of which I have cut a triangular opening for the nose and mouth. As soon as the patient has reached the second stage of anaesthesia I continue with open ether; half a minute to one minute after starting the pure ether I cover the entire mask with a large pad of gamgee wool in the middle of which I have previously cut a "window" two inches square. I then continue to carry on the anaesthetic with open ether or change to the warm ether vapour delivered by the hand pump thro' a Shipway apparatus.

This is the method recommended by Dr F. E. Shipway himself (B.M.J. Nov: 10th 1917, Section of Anaesthetics) and I have found it to give good results. In abdominal operations, where complete relaxation of the muscles is required, and where the not unusual "Ether spasm" is apt to trouble the surgeon, I am in the habit of using more of the C.E. mixture, and may continue to use it till the peritoneum is opened, but I always aim at using as little chloroform as possible when the patient is in a septic condition.

(b)/

(b) Ether:-

From what I have already stated it can be gathered that I look upon ether as the routine anaesthetic in war surgery. I had many opportunities of studying the methods of somewhere between twenty and thirty anaesthetists, at our group of C.C.S's (there were 12 C.C.S's within a few miles of each other) last autumn, and all used ether much more freely than any other anaesthetic. My own estimate that I used thirty (30) ounces of ether for every ounce of chloroform in my whole series of cases is probably fairly accurate. At Brighton I used ether almost exclusively. I was able to have my patients prepared before hand, and  $\frac{1}{8}$  grain morphine with  $\frac{1}{150}$  grain atropine was given hypodermically as a routine half an hour before operation.

I then induced anaesthesia by a method I first saw used by Dr Luke in Edinburgh in 1903. The ordinary Hewitt's Wide Bore Ether Inhaler is the type I use, with a large rubber bag having a capacity of one gallon. To the bottom end of this bag a vulcanite stop cock is fitted.

Having filled my ether chamber in the usual way, and warmed my rubber bag with hot water, I spray 5 c.c. of pure ethyl chloride into a small glass tube (a B.W. & Co's tabloid tube is excellent for the purpose) with a piece of rubber tubing two inches long fitted to its/

its end. I fit this tubing over the end of my stop cock, place a small mouth prop between the patient's teeth, apply the ether chamber and face piece to the face of the patient - the ether regulator being of course at 0 - and catch a good expiration in the bag. I then tip up my chloride of ethyl tube allowing 2 or 3 c.c.'s of the Ethyl Chloride to go into the bag; in from  $\frac{1}{2}$  to  $\frac{3}{4}$  of a minute I tip the remainder of the ethyl chloride into the bag, and as soon as the patient's breathing becomes deeper and more rapid I gradually turn on the ether. Providing there is no holding of the breath or coughing I keep pushing the regulator further over till the "full" mark is reached - as a rule this is attained within 3 minutes from the time the Chloride of Ethyl is introduced. At this stage, or even before if the respiration indicates, I take off the rubber bag and rapidly shake it "bellows fashion" before reapplying it; this permits the patient to have a fresh air supply and expels any excess of chloride of ethyl from the bag.

My aim in preceeding the ether with Chloride of Ethyl is not to give a full Chloride of Ethyl anaesthesia, but to give a rapid safe and comfortable ether induction. By watching the effect of the primary half dose of Chloride of Ethyl and by immediately removing the bag at the slightest sign of stertor in the breathing one can eliminate any danger of too deep a chloride of/

of ethyl anaesthesia, and I consider this a perfectly safe method of inducing Ether anaesthesia.

Nitrous oxide gas possesses even greater advantages in preceeding ether, but one can always get Chloride of Ethyl when Nitrous oxide gas is unobtainable. The ease and rapidity of this method is of great advantage in short operations. I have certainly found it cause less struggling than any other induction and frequently I have had the patient ready for operation in three minutes.

Working at high pressure, when each surgeon has two tables and many wounded waiting for operation, the saving of two or three minutes over each anaesthetic in "getting them under" is of great importance, consequently I made extensive use of this method of anaesthesia in what seemed likely to be short operations in my C.C.S. work. I had the advantage of working with a surgeon (Captain Newton) whose work was always marvelously neat and rapid, and we have got through as many as 34 operations (of all descriptions) in one shift of 16 hours - 13 hours of actual operating.

I have stated that this Ethyl Chloride-ether sequence was my routine method of induction at Brighton, and there I almost always went on with open ether after getting the patient under. Many of the patients were in a septic condition and I seldom used anything but ether for those cases; but it must be noted that almost all/

all of them had had a preliminary hypodermic of morphia and atropine.

At the C.C.S. as I have already remarked, none of the patients had this hypodermic as a routine - many of them had of course had morphia - and I confined my use of the Ethyl Chloride closed ether sequence to the lighter type of wounds we had to deal with. Without the preliminary hypodermic this method of induction undoubtedly produces a raised blood pressure, cyanosis, and much secretion of mucus, and for these reasons I preferred either an "open" Chloride of Ethyl-ether sequence, or a plain C.E. ether sequence, when the condition of the patient deemed it advisable, or the saving of time was not a great object. The "open method" of giving Chloride of Ethyl and ether I have adopted is the one described by Dr J. H. Barton (in the Practitioner of Sept. 1907). I have the ordinary Skinner's mask covered with a layer of coarse turkish towelling; I fit a piece of gamgee over the face as described under C.E. induction, I then start with a few drops of C.E. (2 and 3) on the mask and encourage the patient to breathe quietly and to keep quite still, having given 20 to 30 drops of C.E. on the open mask, I now cover the mask with a large piece of gamgee, as if I were going to give open ether, and proceed to drop out of the Chloride of Ethyl tube this anaesthetic through the/

the "window" of the gamgee.- I say "drop" because though the Chloride of Ethyl tends to spray it is quite easy with a little practise to regulate this spray into a drop. I generally use from 4 to 8 c.c. of the Chloride of Ethyl, taking from one to one and a half minutes in the process, and then proceed with open Ether as I would after the C.E. induction. Here again I do not aim at a deep Ethyl Chloride narcosis, and have frequently given 8, 9 or even 10 inductions from one tube of 50 c.c. There is not as a rule much cyanosis or secretion of mucus by this method, but I have frequently observed great excitement and struggling, and that is my main objection to its use. I have thought that by the use of the preliminary half drachm of C.E. and encouraging the patient to breathe quietly and not be frightened I got better results but I have certainly seen more excitement under this open Chloride of Ethyl-ether sequence in nervous wounded men than in any other form of anaesthesia. Still it is a rapid and pleasant method of inducing ether anaesthesia in certain types of cases and was greatly used by anaesthetists at our group of C.C.S.'s.

In almost all cases of the severely wounded at the C.C.S. (where they were unprepared for operation) or in the secondary operations required at the Base upon that type of patient, I consider the best results are/

are obtained by a C.E. induction as I have already described, and then proceeding to warm ether as delivered by the Shipway apparatus. It takes a little time to become familiar with this apparatus but when one has got into the way of using it I am convinced it is one of the best methods of giving an anaesthetic to a very sick man. The warm ether vapour produces but little irritation (and this is particularly noticeable in the after effects of the anaesthetic) and can be given by the mask under its gamgee covering, by the nasal tube or by the intra-tracheal method. By bubbling oxygen thro' the ether one can get a light anaesthesia as I have described, of the greatest value in long operations upon badly wounded patients. One or two "tips" I learned by experience about the Shipway apparatus .-

- (1) Always test your apparatus before applying your mask - you will thus avoid the risk of pumping pure chloroform into (or on to) the patient - as has happened when the tubes have been wrongly connected.
- (2) Do not take the stop cock switch as your guide to C. or E. - watch the bubbles through each bottle.
- (3) If you cannot have the same Shipway apparatus each time you are giving anaesthetics, endeavour to have the same hand bulb for pumping - you then get to know how much vapour you deliver each squeeze you give.

(4)/



- (4) Having induced with C.E. and E. on the open mask, have a second mask already attached to your Shipway delivery tube and start pumping slowly.
- (5) If your patient shows signs of "coming out" or not "going under" when using a nasal catheter attached to the delivery tube, it is useful to plug the "free" nostril with cotton wool.

(c) Ethyl-Chloride:-

The chief value of this anaesthetic has been its advantage as an induction agent with ether. It possesses the great advantage of portability over Nitrous Oxide Gas, and was always available when Nitrous oxide gas very often was not. I have frequently used it alone for minor operations in the wards, or in any case where a brief anaesthesia only was required. I give this anaesthetic precisely as I have described under Ether, and with the same apparatus. Sir Frederick Hewitt pointed out the value of having a large bag when giving this anaesthetic by the closed method and I have always endeavoured to have a bag of one gallon capacity.

The only other rule I make is to always have a mouth prop inserted before starting the anaesthetic - you may want to pull out the tongue and find a severe spasm of the Maseter muscles keeping the jaws rigid.

(d)/

(d) Gas and Oxygen:-

My experience of this anaesthetic in Major Surgery only started with my C.C.S. work last July. I had the good fortune to be present at a lecture and subsequent demonstration upon the value of Gas and Oxygen in certain of the wounded, given by Captain Marshall. He showed us interesting records of Blood Pressures taken at 2 hourly intervals after operation under a General Anaesthetic. Those showed the fall in Blood Pressure, about two hours after an Ether Anaesthesia, the more rapid and more marked fall in blood pressure after Chloroform, and the negligible fall of blood pressure at any time after Gas and Oxygen. I had all the distrust of a sceptic at this American method of anaesthesia, but in my four months experience at a C.C.S. nothing impressed me more than the marvellous condition of a desperately ill patient ten minutes after a serious operation under Gas and Oxygen. I will just briefly give the rough notes of three of my own cases.-

Case I.

Private R. J., aged 19. Badly smashed right leg. Flesh wound in left leg. Admitted 8 p.m., Sept. 18th. Cold, collapsed and almost pulseless. Put into Resuscitation Ward and kept there all night with no sign/

sign of improvement. At 7 a.m. next day still no improvement and right leg starting to smell. Resuscitation officer asked Captain Newton if he would operate. Patient's pulse could not be properly counted. I gave Gas and Oxygen and a rapid amputation was done through Right Thigh. Intra-venous saline was given at same time. That night patient's pulse and general condition much improved, this was maintained next day, on the 21st however gas gangrene was found to have supervened in left leg and a further amputation of this limb was necessary. The patient was again in quite good condition after the second amputation, but his left stump became gangrenous and he died 2 days later from the effect of Gas Gangrene.

#### Case 2.

J. S., a poorly developed lad of 18, badly wounded Oct. 4th in both arms and both legs. Patient lay on the operating table from 3 p.m. till 5 p.m. till a fresh surgical team came on duty. No pulse could be felt at the wrist and patient appeared to be dying. As soon as a fresh surgeon was available to assist, I gave Gas and Oxygen. Captain Newton rapidly amputated the right arm just below the shoulder, another surgeon excised the wounds of one leg, whilst a third surgeon similarly dealt with the wounds of the other leg. Captain Newton also partially amputated the left hand. An intra-venous saline/

saline was given at the same time. At 7 p.m. the blood pressure was 87, and a pulse was quite perceptible at the wrist. The patient gradually improved and was eventually evacuated to the Base.

### Case 3.

J. B., aged 22, badly wounded Nov. 1st in both legs and left arm, pulse just perceptible: rate 132. After being in Resuscitation ward several hours an amputation of the wounded arm was rapidly done. The wounds in the legs were freely opened up for drainage. Patient's condition was quite good next day - the following day however - (Nov. 3rd) Gas Gangrene was found to have developed in left leg, and amputation was deemed advisable. The patient stood this operation well, but the following day his other leg was also found to be gangrenous, and the desperate remedy of a further amputation of that limb was successfully carried out under Gas and Oxygen. Intra-venous saline was given on each occasion. This patient's condition improved after each amputation, but the toxæmia of gas gangrene was too great and he died on the day following the last amputation. I have cited those cases as examples of the desperate cases I have seen operated upon under Gas and Oxygen and my surgeon agreed with me that in Private Practice, one would have been afraid to touch them./

them. Certainly two of them subsequently died, but the mortality from any case of Gas Gangrene is inevitably great, and one is justified in operating under Gas and Oxygen anaesthesia in even the most desperate cases to try and avert the spread of that condition. Secondary Haemorrhages are also most suitable cases for Gas and Oxygen, and I have anaesthetised almost moribund cases of that type. It is an anaesthetic requiring the closest care and attention in its administration.

I have so far not been fortunate enough to see an expert American Anaesthetist giving the anaesthetic, but from my own limited experience I am convinced that this anaesthetic will shortly become the "Anaesthetic of Choice" in even the most Major Surgery. At present its use in the English Army is confined to those cases to whom one is really afraid to give any other anaesthetic. One has only got to see (as I have seen) a patient who has just had an amputation through the thigh, smoking a cigarette within 10 minutes of his arrival in the ward from the theatre, to realize how little effect this anaesthetic has per se upon the vital centres. The art of administration of this anaesthetic can only be acquired by practise and assiduous attention to the narrow margin dividing "not enough" and "too deep". Three important factors in its administration are.-

(1)/

- (1) A hypodermic of morphia and atropine before administration.
- (2) Perfect quiet during the induction period.
- (3) An even pressure of the mixture of gas and oxygen in the bag throughout the administration.

(e) Local Anaesthesia:-

My experience of this form of anaesthesia has been almost entirely confined to the Head Cases at the C.C.S. There I saw Professor Harvey Cushing doing nearly every kind of brain injury under a local anaesthetic. My surgeon followed his practice in many cases and we found a 1% solution of Novocain in Isotonic Saline, with 3 to 5 m. of Adrenalin 1 in 1000 added to each drachm of the solution, gave most excellent results. I will refer more particularly to this form of anaesthesia under "Type of Operation" - Head Injuries.

Of Spinal anaesthesia, Intra-venous or Rectal Ether - I have had no experience in operations upon wounded men; Spinal anaesthesia is used to a certain extent and has certain advantages in a few special cases to which I will briefly refer later.

3. Type of Operation:-

(a) Head Injuries:- During my four months up at a C.C.S. I was attached to a hospital which was specializing/

specializing in Head Injuries. Those wounds might be anything from a superficial scalp injury to "penetrating head" with extensive laceration and destruction of brain substance. Our school (of which Professor Harvey Cushing was an advocate) practised Local Anaesthesia in all cases - Other surgeons preferred a general anaesthetic - I worked for a month for a surgeon who used a local anaesthetic in addition to a general one, his idea being to have all the advantages of a comparatively "bloodless" area combined with a light general anaesthetic. He required me to get the patient quiet with C.E., then he used a 1% Novocain in .8% Sodium Chloride Solution to which he added Adrenalin 5 m. of the 1 in 1000 solution to each drachm of Solution. After infiltrating this solution all round the area of the scalp to be excised he required me to keep the patient lightly under with C.E. delivered by the Shipway apparatus. I can speak most enthusiastically of this form of anaesthesia and I never saw any ill effects of using a small quantity of Chloroform with Adrenalin. My other surgeon operated upon a good number of his penetrating head injuries under Local Anaesthesia alone, using a 1% Novocain Solution with 3 m. of Adrenalin 1 in 1000 to each drachm. He preceded all his locals with Omnopon 1 c.c. of the 2% Solution made by Hoffman La Roche & Co.

The/

The disadvantages of this method are.-

1. Time involved in carrying out technique, and allowing time for the Anaesthetic to have full effect - this is a most important point when numbers of wounded are awaiting attention.
2. Many "restless" head cases would not permit of the local anaesthetic being given, even though under the influence of Omnopon.
3. A considerable number of the cases were not quiet under the anaesthetic throughout the operation.
4. Many head cases are wounded elsewhere and required a general anaesthetic under those circumstances.

On the other hand Comatose head cases are not good subjects for a general anaesthetic. Professor Cushing did nothing but head work, had ample assistance and could take his own time over a case, consequently he had many fewer failures in local anaesthesia compared with the ordinary C.C.S. surgeon. My own conclusions as to the relative merits are briefly.-

1. All "Comatose" heads should be done under a local anaesthetic.
2. When time permits as many other heads as possible should be done under a local anaesthetic.
3. As a routine when work is strenuous, then general anaesthesia seems to give the most profitable all round results. "The greatest good for the greatest number."



Give as light an anaesthetic as is compatible with the surgeon's needs.

I induce with C.E. on an open mask, then go on with the Shipway apparatus - using the nasal tube in many of the cases and a great deal more Ether than Chloroform.

Almost all penetrating heads have had Morphia or Omnopon before hand. I found they took Ether from the Shipway quite well.

I do not think the anaesthetic matters a great deal in scalp injuries and in penetrating injuries of the Dura, the mortality rate of my surgeon (certainly an experienced surgeon in brain work) was very little higher than that of Professor Cushing, who had the extra experience, time and assistance to do this special work.

(b) In Face and Jaw Injuries:- I found a C.E. mixture delivered by a nasal tube attached to a Shipway apparatus a most valuable method of continuing the anaesthetic after induction, on an open mask.

Intra-tracheal Ether is also most useful in this type of case. Oxygen is often a valuable adjuvant to the anaesthetic in this as in many other type of case.

(c) Penetrating Chest Wounds:- A light chloroform or C.E. anaesthetic given with Oxygen through a Shipway apparatus suits this type of case very well, but for the/

the septic cases - such as Empyema following on a haemo-thorax with a foreign body in the lung, I prefer Gas and Oxygen. A light anaesthetic only is required and many surgeons were doing their " chests " under a local anaesthetic with the addition of a light Gas and Oxygen General Anaesthesia.

(d) Penetrating Abdominal Injuries:- Here we have probably the most difficult type of case to anaesthetise satisfactorily. Many of the cases are suffering severely from shock. The wounds in the intestines are often numerous and the operation of necessity a prolonged and severe one. I have found Ether and Oxygen by the Shipway the most useful anaesthesia in my hands, but I have just at the time of writing, heard that Gas and Oxygen is being used in those severe types of abdominal wounds and I feel sure that this anaesthetic combined with Ether when required, will be more generally used - as is the practise amongst many of the American Surgeons.

(e) All Severe Injuries to the Limbs when damage to the bones, vessels or soft parts is so extreme as to require an amputation - are best dealt with under Gas and Oxygen. In those cases a quick and dextrous surgeon is just as essential as a skilled anaesthetist. This type of case has also been frequently operated upon under a spinal anaesthesia - induced by a 2% Novocain solution/

solution with good results. But the general opinion is that this is not as safe an anaesthetic as Gas and Oxygen, given by an anaesthetist experienced in its administration. I have dealt with all the more severe types of war time injury and in those have summed up my experiences of the relative merits of Gas and Oxygen, Ether and Chloroform, with special reference to Local Anaesthesia in Head Injuries. For the more lightly wounded, where the operation necessary can usually be completed under 20 minutes, I have already signified my preference for the Ethyl Chloride and Ether method of Anaesthesia, and for such cases requiring a longer anaesthesia my preference is for Ether by the open method or Shipway Apparatus.

Regarding preliminary hypodermic medication, I like Morphia  $\frac{1}{8}$  and Atropin  $\frac{1}{150}$  to be given as a routine. I have tried combining Scopolamine  $\frac{1}{100}$  gr. with those two drugs, but am not convinced that it possesses any special advantages and it certainly depresses the respiratory centres in many cases.

As regards the after effects of my anaesthetics, I have not much opportunity of following up my cases at the C.C.S. but in my whole series my conclusions are.-

Gas and Oxygen causes less nausea and sickness than any anaesthetic.

Chloroform or Ether or the C.E. mixture combined with/

with Oxygen cause less sickness than either Chloroform or Ether alone - but it must be remembered that those anaesthetics with Oxygen were usually of the light type.

I have noticed more vomiting after the Chloride of Ethyl and Ether Anaesthesia than any other, but here again most of those patients (I refer to my C.C.S. work) were unprepared and many of them had cocoa or some such hot drink shortly before coming to the theatre. There were many more cases of Bronchitis after the Ether Anaesthesias than one has in Private Practice, but for one thing "war time" Ether is certainly not as pure as the Ether I was in the habit of using in Private Practice and many of the cases had been coughing for some days or even weeks before they were wounded.

Since writing the above I have had the opportunity of seeing Professor Harvey Cushing and he tells me he uses a 1% Novocain solution for local anaesthesia in his head cases, adding 1 m. of Adrenalin 1 in 1000 solution to each c.c. of the Novocain Solution. This is almost identical with the local anaesthetic used by my own surgeon. Professor Cushing's technique is to infiltrate the scalp all round the area to be excised and wait for half an hour before proceeding with the operation. Occasionally he finds it necessary to further infiltrate the pericranial area before using his special burr trephine. I have also just had the opportunity/

opportunity of seeing a new Gas and Oxygen apparatus devised by Captain E. G. Boyle and used by him for some little time at the First London General Hospital.

This apparatus allows of the use of warmed Ether in addition to the Gas and Oxygen, and has met with the approval of the Medical Authorities in the Service.

I am convinced that this form of anaesthesia will become much more generally used in War Surgery in the near future.

In conclusion, I do not pretend to have presented anything very new or very original in this paper, but I have learned much from my experience in the work I have described, and there is one most important factor in all anaesthesias I have not touched up. It is just as important to gain the confidence of your patient in this as in all other realms of medicine. Encourage, pacify, or stimulate your patient by voice and manner - always remembering that a good induction is more than halfway to a good anaesthesia throughout.